

FORM PTO-1390
(REV 10-2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

Az. 2796

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

09/913986

INTERNATIONAL APPLICATION NO.

PCT/EP00/00380

INTERNATIONAL FILING DATE

19 January 2000

PRIORITY DATE CLAIMED

16 February 1999

TITLE OF INVENTION

METHOD AND APPARATUS FOR TREATING SUBSTRATES

APPLICANT(S) FOR DO/EO/US

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☐ Other items or information:

"Express Mail" Mailing Label Number EL 43 6586668USDate of Deposit August 16, 2001

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner of patents and trade marks, Washington, D.C. 20231.

Rosalie A. Centeno
Rosalie A. Centeno, Secretary

U.S. APPLICATION NO. (If known, fill in 37 CFR 1.53) <div style="font-size: 24pt; font-weight: bold;">09/913986</div>		INTERNATIONAL APPLICATION NO. PCT/EP00/00380		ATTORNEYS DOCKET NUMBER Az.2796	
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17. ☒ The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

- Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1000.00
- International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$860.00
- International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00
- International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00
- International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00

ENTER APPROPRIATE BASIC FEE AMOUNT =

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total claims	28 - 20 =	8	X \$18.00
Independent claims	2 - 3 =	0	X \$80.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			X \$270.00

TOTAL OF ABOVE CALCULATIONS =

☒ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.

SUBTOTAL =

Processing fee of \$130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).

TOTAL NATIONAL FEE =

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property

TOTAL FEES ENCLOSED =

CALCULATIONS		FIO USE ONLY
\$	860.00	
\$		
\$	144.00	
\$		
\$		
\$	1,004.00	
\$		
\$	1,004.00	
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\$	1,004.00	
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\$	1,004.00	
Amount to be refunded:		\$
charged:		\$

☒ A check in the amount of \$ 1,004.00 to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-1653. A duplicate copy of this sheet is enclosed. In the event there is any discrepancy in the amount sent herewith or at any time in the future please charge any additional fee, credit or overpayment to the above deposit account number.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.437(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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26,255

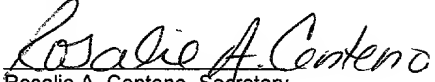
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Rosalie A. Centeno, Secretary

In the Application of Peter Dress, et al

Ser.No.: Not Known Yet (Based on PCT/EP00/00380 filed January 19, 2000 and German priority document 199 06 398.2 filed 16 February 1999)

For: METHOD AND APPARATUS FOR TREATING SUBSTRATES

Filed on: August 16, 2001

Assistant Commissioner for Patents

Washington, DC 20231

PRELIMINARY AMENDMENT ACCOMPANYING PCT NATIONAL STAGE APPLICATION

Sir:

Prior to examination, please amend the above-identified application as follows.

IN THE SPECIFICATION:

On page 1, immediately after the title, please insert the following heading:

--Background of the Invention--.

On page 3, at the top of the page, please insert the following heading:

--Summary of the Invention--.

On page 8, between lines 4 and 5, please insert the following heading:

--Brief Description of the Drawing--;

On page 9, between lines 11 and 12, please insert the following heading:

--Description of Preferred Embodiments--.

On page 10, at line 14, please delete "underside" and insert -- surface --.

On page 13, at line 19, please delete "underside 11" and insert --main body 8--.

On page 14, at line 23, please delete "B" and insert --13--.

On page 15, at line 8, please delete "main body 5" and insert --main body 8--.

On page 19, after line 5, please insert the following two paragraphs:

--The specification incorporates by reference the disclosure of German priority document 199 06 398.2 of 16 February 1999 and International priority document PCT/EP00/00380 of 19 January 2000.

The present invention is, of course, in no way restricted to the specific disclosure of the specification and drawings, but also encompasses any modifications within the scope of the appended claims.--

IN THE CLAIMS:

Please cancel claims 1 - 29, and replace them with the attached claims 30 - 57.

IN THE DRAWINGS:

Please replace page 1 of the drawings with the attached, which shows corrections in red.

REMARKS

Claims 30 – 57 are pending in the application.

Appropriate headings have been added to the specification, and the abstract and claims from the literal translation have been replaced by an abstract and claims drafted in conformity with U.S. Patent practice.

The application in its amended state is believed to be in condition for allowance. However, should the Examiner have any comments or suggestions, or wish to discuss the merits of the

[illegible]

Robert - Geck

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30. An apparatus for coating substrates, comprising:

a substrate holder for holding thereon a substrate in such a way
that a surface of said substrate that is to be coated is exposed and is
directed downwardly;

a means for rotating said substrate holder; and

a cover that is securable to said substrate holder, wherein said
cover, together with said substrate holder, are adapted to form a
sealed chamber for receiving the substrate.

31. An apparatus according to claim 30, wherein a holding
mechanism is provided on said substrate holder for holding the
substrate by means of vacuum.

32. An apparatus according to claim 31, wherein a holding
mechanism is provided on said substrate holder for holding said cover
by means of vacuum.

33. An apparatus according to claim 32, wherein said holding
mechanisms for the substrate and for said cover are connected to a
common vacuum source.

34. An apparatus according to claim 32, wherein said holding
mechanisms for the substrate and for said cover are adapted to be
controlled independently of one another.

35. An apparatus according to claim 32, wherein at least one sealing means is provided for delimiting a vacuum region between said substrate holder and said cover.

36. An apparatus according to claim 30, wherein said substrate holder is provided with a recess for an at least partial accommodation of the substrate.

37. An apparatus according to claim 30, wherein a centering mechanism is provided for a mutual centering of said cover and said substrate holder.

38. An apparatus according to claim 37, wherein said centering mechanism is in the form of at least one slanted centering portion on at least one of said substrate holder and said cover.

39. An apparatus according to claim 30, wherein said cover is symmetrical relative to a central axis C thereof.

40. An apparatus according to claim 30, wherein a notch is provided in an outer region of a portion of said cover that defines said chamber.

41. An apparatus according to claim 40, wherein said notch tapers outwardly.

42. An apparatus according to claim 40, wherein said notch is inclined on a side thereof that faces said substrate holder.

43. An apparatus according to claim 39, wherein said cover is symmetrical relative to a central plane B thereof.

44. An apparatus according to claim 30, wherein a device is provided for turning said cover.

45. An apparatus according to claim 40, wherein a receiver is provided for supporting said cover.

5 46. An apparatus according to claim 45, wherein a device is provided for raising and lowering said receiver.

47. An apparatus according to claim 45, wherein a rinsing and/or drying device is provided for said cover.

10 48. An apparatus according to claim 47, wherein said rinsing and/or drying device is part of said receiver and is provided with at least one nozzle that is directed against at least one of said cover and said notch.

49. An apparatus according to claim 48, wherein at least one nozzle is adapted to be supplied with a rinsing and/or drying fluid.

15 50. An apparatus according to claim 49, wherein said rinsing fluid contains a solvent.

51. A method for coating substrates, including the steps of:

20 holding a substrate on a substrate holder in such a way that a surface of the substrate that is to be coated is exposed and is directed downwardly;

securing to said substrate holder a cover that together with said substrate holder forms a sealed chamber for receiving the substrate;

rotating the substrate together with said substrate holder.

52. A method according to claim 51, wherein at least one of the substrate and said cover is held or secured on said substrate holder by means of vacuum.

53. A method according to claim 52, which includes the step of centering said cover and said substrate holder relative to one another prior to the holding or securement.

54. A method according to claim 51, wherein after said step of rotating the substrate, the securement of said cover is released independent of the holding of the substrate.

55. A method according to claim 51, wherein during said step of rotating the substrate a side of said cover that faces away from the substrate is rinsed and/or dried.

56. A method according to claim 51, wherein a rinsing or drying fluid is conveyed against said cover by means of at least one nozzle.

57. A method according to claim 51, which includes the step of turning said cover between successive ones of said rotating steps.

ABSTRACT

To achieve a uniform coating of a substrate, with an apparatus and a method for coating substrates, according to which the substrate is supported on a substrate holder in such a way that a substrate surface that is to be coated is exposed, and the substrate is rotated together with the substrate holder, a cover can be secured to the substrate holder and together with the substrate holder forms a sealed chamber for the substrate.

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METHOD AND APPARATUS FOR TREATING SUBSTRATES

The present invention relates to a method and an apparatus for coating substrates, according to which the substrate is held on a substrate holder in such a way that the substrate surface that is to be coated is exposed, and the substrate is rotated together with the substrate holder.

An apparatus of this type is known, for example, from EP-A 0 711 108. This apparatus includes an initial coating station, whereby a downwardly directed substrate surface that is to be coated is moved past a capillary gap that is supplied with lacquer to coat the substrate surface. The substrate is subsequently moved to a centrifuging station and is rotated or centrifuged within a protective ring that serves to convey away residual lacquer that is centrifuged from the substrate.

DE-A-195 45 573 discloses an apparatus for the uniform application of a lacquer layer to a substrate, according to which a substrate is placed upon a rotary plate with the side that is to be coated facing upwardly. During a centrifuging process, a hood that at least partially covers the substrate is moved from above over the substrate and is slightly spaced therefrom, or is positioned directly upon the substrate.

DE-A-92 18 974 also discloses an apparatus for applying a thin layer, for example of lacquer, upon a substrate by means of a centrifuging device. The apparatus includes a rotary plate upon which

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a substrate that is to be coated is disposed with the surface that is to be coated facing upwardly. A hood can be positioned from above upon the rotary plate in order to form a chamber for receiving a substrate. In this connection, the chamber formed between the hood and the rotary plate is connected to the surrounding atmosphere by means of apertures in the rotary plate. Furthermore, elastic cover strips are provided on the hood and are in contact with upwardly directed edges of the substrate to form a chamber between the cover and the substrate.

US-A-5 042 421 discloses a rotary head arrangement for coating a semiconductor, and includes a rotary plate for supporting the wafer and a disk that surrounds the wafer and can be secured to the rotary plate.

DE-A-40 24 642 furthermore shows a rotary plate for receiving a substrate, which is held on the rotary plate by means of a vacuum.

These apparatus have the problem that the uniformity of the layer thickness achieved by the centrifuging process is not always adequate.

It is therefore an object of the present invention to provide a method and apparatus of the aforementioned type for treating substrates according to which a homogeneous coating of the substrate surface that is to be treated is achieved.

The stated object is realized pursuant to the present invention in that a cover, which can be secured to the substrate holder, together with the substrate holder forms a sealed chamber that receives the substrate. By means of the cover that can be secured to the substrate holder, defined environmental conditions are achieved for the substrate between the substrate holder and the cover. In particular, a static region is formed in such a way within the chamber that the gases disposed therein, for example air, turn together with the substrate holder and the cover secured thereto. Furthermore, the distance between that side of the cover that faces the substrate is kept at a constant value during the rotation process. As a result, relative movements and turbulences between the substrate and gases disposed in the chamber are reduced to a minimum, which leads to a very homogeneous coating of the substrate. In this connection, it is immaterial whether the entire surface that is to be coated is pre-coated, or if only a partial region, such as a central portion of the substrate surface, is pre-coated, and the complete coating is effected by means of the rotation process. The defined environmental conditions for the substrate furthermore permit a more uniform and gradual drying of a solvent contained in the coating. Since the surface that is to be coated is held in a downwardly directed position, there is furthermore ensured that coating medium dislodged from the substrate does not come into contact with side edges or the backside of the substrate.

the recess can offer lateral support for the substrate during the rotation or centrifuging process.

The apparatus is preferably provided with a centering means for the mutual centering of the cover and of the substrate holder in order to ensure a defined position of the cover relative to the substrate holder as well as to the substrate. For an economical and simple centering, the centering means is preferably provided with at least one slanted centering portion on the cover and/or on the substrate holder. In order to prevent an imbalance and a lateral shifting of the cover relative to the substrate holder during the rotation thereof, the cover is preferably symmetrical relative to a central axis.

Pursuant to one particularly preferred embodiment of the present invention, to form adequate space for the residual centrifuged-off lacquer, a notch is provided in the outer region of that portion of the cover that defines the chamber. Forming the notch in the outer region ensures that the residual lacquer, due to the centrifugal forces resulting during the rotation, is reliably conveyed away from the region of the substrate and also of the substrate holder in order to protect against contamination. In this connection the notch is preferably tapered outwardly in such a way that the side that faces the substrate holder is inclined. This further improves the conveyance of the lacquer from the substrate and from the substrate holder.

Pursuant to a further particularly preferred specific embodiment of the present invention, the cover is symmetrical relative to its horizontal central plane, and a device for turning the cover is provided so that the cover can be placed into a first position and into a position rotated by about 180°. A receiver, which can be adjustable in height, is preferably provided for supporting the cover in order to support the cover between the rotation processes, when the cover is secured to the substrate holder. To permit cleaning of the cover during or between the respective centrifuging processes, a rinsing and/or drying device is provided for the cover. The rinsing and/or drying prevents contamination of the substrate that is to be treated subsequently with such contamination adhering to the cover. Pursuant to a particularly advantageous specific embodiment of the present invention, the rinsing and/or drying device is part of the receiver, and has at least one nozzle that is directed against the cover and/or the notch. Directing a nozzle against the notch is particularly advantageous since, as indicated above, lacquer residue preferably collects in these notches and would fill these notches over time if they were not cleaned. At least one nozzle can preferably be supplied with a rinsing fluid that contains solvent in order to remove the lacquer residue. After the rinsing, a drying fluid is preferably directed against the cover via the same or a further nozzle in order to dry the cover.

To ensure a good hold of the substrate on the substrate holder, without adversely affecting the substrate surface that is to be coated, the substrate holder has a holding mechanism for holding the substrate with vacuum.

5 Pursuant to one preferred specific embodiment of the present invention, the substrate holder is furthermore provided with a holding mechanism for holding the cover with vacuum. The holding mechanisms for the substrate and the cover are advantageously connected to a common vacuum supply in order to have to provide only a single vacuum source, such as a vacuum pump. In this connection, the holding mechanisms for the substrate and the cover can preferably be controlled independently of one another, for example by a valve unit, since the cover is secured to the substrate holder only for the rotation or centrifuging process, whereas the substrate is held on the substrate holder over longer time periods, especially also during a pre-coating process.

In order to achieve a well defined vacuum region between the substrate holder and the cover, and to thus achieve a good hold, a seal is provided between the substrate holder and the cover.

20 Pursuant to one specific embodiment of the present invention, a recess is provided in the substrate holder for the at least partial accommodation of the substrate; by means of this recess, a centering of the substrate relative to the holder can be achieved. Furthermore,

The object of the present invention is also realized by a method for treating substrates, according to which the substrate is held on a substrate holder in such a way that the substrate surface that is to be treated is exposed and is directed downwardly, and the substrate is rotated with the substrate holder, wherein a cover is secured to the substrate holder and together with the substrate holder forms a sealed chamber for the substrate. By securing the cover to the substrate holder, and by forming the sealed chamber, the aforementioned advantages are achieved.

Pursuant to one particularly advantageous specific embodiment of the present invention, that side of the cover that faces away from the substrate is rinsed and/or dried during the rotation process. Due to the simultaneous rinsing and/or drying with the rotation process, time is saved since the rinsing and/or drying does not have to be carried out in an intermediate step. Furthermore, the centrifugal forces resulting from the rotation process enhance the rinsing and/or drying.

The cover is preferably turned between successive rotation processes so that a clean side of the cover is always directed to the substrate that is to be treated, whereas the side that has become contaminated from the previous rotation process faces away from the substrate and can be cleaned.

The present invention is particularly suitable for the thin layer industry, especially for the manufacture of LCD image screens, masks

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Figs. 1-6 show an operating sequence for the inventive coating apparatus 1. The apparatus 1 essentially comprises a substrate receiving and transporting unit 2 and a cover unit 3.

The receiving and transporting unit 2 is provided with a transport device, which is not shown in detail, and a substrate holder 5, which by means of a rotary shaft 6 is coupled with a rotation device, which is not illustrated in detail. The rotation device is connected to the transporting device and is movable therewith. A receiving and transporting unit of this type, having a transporting device, a rotation device and a substrate holder, is known, for example, from the previously mentioned EP-A-0 711 108, which to that extent is hereby incorporated by reference to avoid repetition.

5 The substrate holder 5 comprises a base plate 8 which, on the upper side thereof that faces the transport device, is provided with a recess 10 for the appropriate accommodation of the rotary shaft 6. The substrate holder 5 is rotationally symmetrical relative to an axis of rotation A of the rotary shaft 6. A recess 12 for receiving a substrate 13 is formed in the underside 11 of the base plate 8, which underside faces away from the transport device. The substrate 13 is accommodated in the recess 12 in such a way that a surface 15 of the substrate that is to be coated faces away from the substrate holder and is exposed. The depth of the recess 12 corresponds to the thickness of the substrate that is to be accommodated, so that the underside 11 of the base plate 8 is flush with the surface 15 of the substrate that is to be coated when the substrate 13 is inserted into the recess. However, if desired, the underside 15 can also be spaced from the plane defined by the underside 11 of the base plate 8, and in particular can project downwardly beyond the underside 11. The substrate 13 is held on the substrate holder 15 by non-illustrated vacuum openings that are formed in the base plate and communicate with a non-illustrated source of vacuum, such as a vacuum pump.

20 The base plate 8 is provided with a slightly conical, downwardly tapering outer periphery 16 which, as will be described subsequently, serves as a slanted centering portion.

for the manufacture of semiconductors, semiconductor or ceramic substrates, in order to provide right-angled or round plates with a uniform layer of lacquer or another initially liquid medium, such as color filters or special protective layers.

5 The present invention will subsequently be explained with the aid of preferred specific embodiments in conjunction with reference to the drawings; in the drawings:

10 Fig. 1 is a schematic illustration of the inventive apparatus, according to which a substrate holder that carries a substrate, and a cover, are spaced from one another;

 Fig. 2 is a further schematic illustration of the inventive apparatus, whereby the cover is in contact with the substrate holder;

15 Fig. 3 is a further schematic illustration of the inventive apparatus of Fig. 1, whereby the cover is secured to the substrate holder and rotates therewith;

 Fig. 4 is a further illustration of the inventive apparatus of Fig. 1, whereby the cover is again removed from the substrate holder and the substrate holder is moved away from the cover;

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In addition to the vacuum openings for holding the substrate 13, the substrate holder 5 is provided with a further vacuum holding device 17 having cup-shaped vacuum grippers 18 that communicate with a vacuum source via non-illustrated lines. This vacuum source is the same as that with which the vacuum openings for holding the substrate 13 communicate. However, by means of valves the vacuum grippers 18 can be supplied with a vacuum independently from the vacuum openings for holding the substrate 13. The vacuum grippers 18 are disposed radially adjacent the base plate 8 of the substrate holder 5, and are recessed relative to the underside 11. Although only two vacuum grippers 18 are illustrated in Fig. 1, it should be noted that a plurality of vacuum grippers 18 are rotationally symmetrically provided about the periphery of the substrate holder 5. Instead of using a common source of vacuum for the vacuum grippers 18 and the vacuum openings for the substrate, it would also be possible to use two separate vacuum sources.

The cover unit 3 essentially comprises a cover element, to be called a cover 20, and a receiving element, i.e. a receiver 22, for accommodating the cover. As shown in Fig. 1, the receiver 22 has a basin-shaped cross-sectional configuration with a base plate 24 and a side wall 25 that extends perpendicular thereto.

The cover 20 has a central wall 28 with a horizontal central plane B. The cover 20 is symmetrical relative to the horizontal central

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As shown in Fig. 3, provided within the receiver 22 is a nozzle 40 that is directed against the underside of the cover 20, especially against the recess thereof; by means of the nozzle a rinsing and/or drying fluid is sprayed against the underside of the cover 20. The nozzle 40 is movable within the receiver 22, as indicated by the arrow D. Instead of the single nozzle, a plurality of nozzles can also be provided.

The cover unit 3 is furthermore provided with a non-illustrated turning device for turning the cover 20 about the central plane B, as illustrated in Fig. 5.

Figures 7 and 8 illustrate an alternative embodiment of the substrate holder 5 with an alternative embodiment of the cover 20. The same reference numerals are used in Figures 7 and 8 as in Figs. 1-6 for the same or similar elements.

The substrate holder 5 again has a base plate 8, which on its upper side is provided with a recess 10 for receiving a rotary shaft. In contrast to the embodiment of Figs. 1-6, the underside 11 of the main body 8 that faces the substrate is not provided with a recess for accommodating the substrate 13. The underside 11 is flat, and the substrate 13 is held against the base plate 8 via vacuum openings 50 in the main body 11. As was the case with the first embodiment of Figs 1-6, the vacuum openings 50 are in contact with a vacuum source. Formed in the underside 11 of the main body 8 is a groove that

surrounds the vacuum openings 50 for receiving a sealing element, such as an O-ring 52.

Vacuum openings 54 are formed in the outer portion of the base body 8 of the substrate holder 5; these vacuum openings communicate with a vacuum source and replace the vacuum grippers 18 of Figs. 1-6. Although only two vacuum openings 54 are illustrated in Fig. 7 it should be noted that a plurality of vacuum openings 54 are rotationally symmetrically provided relative to the axis of rotation A of the substrate holder 5. Provided in the underside 11, adjacent to the vacuum openings 54, are two circumferential grooves for receiving sealing elements 56, such as O-rings.

The cover 20 is again provided with a central wall 28 having a central plane B to which the upper and lower sides of the cover 20 are symmetrical. Therefore, again only the upper portion of the cover 20 will be described. A circumferential flange 30 having a planar upper surface 31 again extends upwardly in the outer region of the central wall 28. The flange is rotationally symmetrical relative to the central axis C, which pursuant to Fig. 7 coincides with the axis of rotation A of the substrate holder 5. The flange 30 is again provided with a notch 32 that is adjacent to and flush with the central wall. By means of the notch 32, an inwardly extending projection 34 of the flange 30 is formed. The inner periphery 62 of the projection is dimensioned such that a substrate B that is to be coated can be received within or

between the projection without contacting the same. The notch 32 has an inclined upper side 60, so that the notch 32 is tapered radially outwardly.

The flange 30 has a further projection 64 that extends axially from the planar upper surface 31 and defines a downwardly tapering inner peripheral surface 66. The downwardly tapering inner peripheral surface 66 is adapted to the outer peripheral shape of the substrate holder 5 and forms a slanted centering portion, so that the main body 5 can slide along the inner peripheral surface 66 until the underside 11 of the main body 8 of the substrate holder 5 rests upon the planar upper surface 31 of the flange 30 of the cover 20. By means of the tapering inner circumferential shape, a centering of the substrate holder 5 relative to the cover 20, and hence a centering of the substrate 13 relative to the substrate holder 5, is ensured.

Although pursuant to Fig. 7 sealing means 56 are provided in the base body 8, these could be formed in the same manner in recesses provided in the planar upper surface 31 of the cover 20.

Fig. 8, which is a top view of the cover 20, clarifies, in addition to the circular shape, also the position of the planar upper surface 31 of the flange 30 that forms the vacuum region that ensures the adhesion or bonding of the cover to the substrate holder. Due to its position, contamination of this region is nearly precluded.

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An operating sequence of the inventive coating process will now be described with the aid of Figs. 1-6, whereby the same sequence is applicable for the elements of Fig. 7.

In Fig. 1, the substrate receiving and transporting unit is moved over the cover unit 3, which is raised in the direction of the substrate receiving and transporting unit by means of a non-illustrated lifting device, as indicated by the respective arrows. At this point in time, the substrate surface 15 is pre-coated, for example by means of a cap coating process, as described in the aforementioned EP-A-0 711 108. By means of the cap coating process, for example a uniform coating in a thickness range of $1\mu\text{m}$ to $2\mu\text{m}$ is applied to the substrate surface that is to be coated.

The substrate holder 5 is brought into contact with the cover 20 as shown in Fig. 2, and by means of the slanted centering portion 16 on the substrate holder, or the slanted centering portion 66 on the cover, the substrate holder is centered, so that the axis of rotation A of the substrate holder, and the central axis C of the cover, coincide. The cover 20 is then drawn against and securely held against the substrate holder 5 by vacuum, either via the vacuum grippers 18 or the vacuum openings 54. As a result, a hermetically sealed chamber 36 is formed between the substrate holder 5 and the cover 20, as best seen in Fig. 7.

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Subsequently, as shown in Fig. 3, the receiver 22 is lowered slightly, so that the cover 20 is no longer in contact with the receiver 22. By means of the non-illustrated turning device, the substrate holder, together with the substrate 13 and the cover 20 secured thereto, are then rotated, whereby excess material is centrifuged from the preliminarily coated upper surface 15 of the substrate 13, with such excess material collecting within the notch 32 of the cover 20 due to the centrifugal force. Due to the fact that the substrate 13 is disposed in the hermetically sealed chamber 36 during the centrifuging process, a homogeneous coating of the substrate over the entire surface thereof is achieved, with deviations relative to the thicknesses of the coating being less than 1% for layer thickness' in the range of 0.2 μ m to 1.0 μ m. In particular, the uniformity of the coating is improved in the corner regions of right-angled substrates. There remains only a small rim portion of less than 2mm in which the uniformity of the coating cannot be guaranteed.

At the same time, by means of the nozzle 40, a rinsing fluid, which contains a solvent, is sprayed against the underside of the cover 20 in order to clean the latter. The cleaning effect is thereby enhanced by the rotation of the cover 20. After the spraying of the rinsing fluid, a drying fluid is conveyed against the underside of the cover to dry the same.

As shown in Fig. 4, after the centrifuging process the cover 20 is again placed upon the receiver 22, and the substrate receiving and transporting unit 2 is moved away from the region of the cover unit 3. As can be seen from Fig. 5, by means of a non-illustrated turning device the cover 20 is turned by 180° relative to the horizontal central plane while the receiver 22 is lowered in order to make the turning possible.

As shown in Fig. 6, after the turning process the receiver 22 is again raised and the cover 20 is placed upon the receiver 22. After the turning process, the previously cleaned side of the cover 20 faces upwardly, while the side that was contaminated by the preceding centrifuging process faces downward. The cover 20 is thus ready for use in a new centrifuging process.

As can be seen from the above description, the cover 20 does not have its own axis of rotation, i.e. it is not rotated itself by a separate turning device, but rather is passively rotated by the driven substrate holder. If the cover were to be actively rotated by its own turning device, a complicated adaptation and alignment of the thereby resulting two axes of rotation relative to one another would be necessary.

Although the present invention has been described in conjunction with preferred specific embodiments of the invention, it is to be understood that the present invention is not limited thereto. For example, for the centrifuging process, the cover 20 could also be

secured to the substrate holder by electromagnets or by other means, such as a mechanical clamping device. In addition, cleaning of the cover is not necessary at the same time as the centrifuging process and could also be effected by means of a brush prior to or during the centrifuging process.

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PATENT CLAIMS

1. Apparatus (1) for coating substrates (13), with a substrate holder (5) on which the substrate is supported in such a way that a substrate surface (15) that is to be coated is exposed and is directed downwardly, and a device for turning the substrate holder (5), characterized by a cover (20) that can be secured to the substrate holder (5) and that together with the substrate holder (5) forms a sealed chamber (36) for receiving the substrate (13).

2. Apparatus (1) according to claim 1, characterized by a holding mechanism (50) on the substrate holder (5) for holding the substrate (13) with vacuum.

3. Apparatus (1) according to claim 1 or 2, characterized by a holding mechanism (18;54) on the substrate holder (5) for holding the cover (20) with vacuum.

4. Apparatus (1) according to one of the preceding claims, characterized in that the holding mechanisms (50;18,54) for the substrate (13) and for the cover (20) are connected to a common vacuum source.

5. Apparatus (1) according to one of the preceding claims, characterized in that the holding mechanisms (50;18,54) for the substrate (13) and for the cover (20) can be controlled independently of one another.

6. Apparatus (1) according to one of the preceding claims, characterized by at least one sealing means that delimits the vacuum region between the substrate holder (5) and the cover (20).

7. Apparatus (1) according to one of the preceding claims, characterized by a recess (12) in the substrate holder (5) for at least partial accommodation of the substrate (13).

8. Apparatus (1) according to one of the preceding claims, characterized by a centering mechanism (16; 66) for the mutual centering of the cover (20) and the substrate holder (5).

9. Apparatus (1) according to one of the preceding claims, characterized by at least one slanted centering portion (16;66) on the substrate holder and/or on the cover.

10. Apparatus (1) according to one of the preceding claims, characterized in that the cover (20) is symmetrical relative to a central axis (C).

11. Apparatus (1) according to one of the preceding claims, characterized by a notch (32) in the outer region of the portion of the cover (20) that defines the chamber.

12. Apparatus (1) according to one of the preceding claims, characterized in that the notch (32) tapers outwardly.

13. Apparatus (1) according to one of the preceding claims, characterized in that the notch (32) is inclined on that side (60) that faces the substrate holder.

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14. Apparatus (1) according to one of the preceding claims, characterized in that the cover (20) is symmetrical relative to its central plane (B).

5 15. Apparatus (1) according to one of the preceding claims, characterized by a device for turning the cover (20).

16. Apparatus (1) according to one of the preceding claims, characterized by a receiver (22) for supporting the cover (20).

10 17. Apparatus (1) according to one of the preceding claims, characterized by a device for raising and lowering the receiver (22).

18. Apparatus (1) according to one of the preceding claims, characterized by a rinsing and/or drying device (40) for the cover (20).

15 19. Apparatus (1) according to one of the preceding claims, characterized in that the rinsing and/or drying device (40) is part of the receiver (22) and is provided with at least one nozzle (40) that is directed against the cover (20) and/or the notch (32).

20 20. Apparatus (1) according to one of the preceding claims, characterized in that at least one nozzle (40) is adapted to be supplied with a rinsing and/or drying fluid.

21. Apparatus (1) according to one of the preceding claims, characterized in that the rinsing fluid contains a solvent.

22. Method for coating substrates (13), according to which the substrate (13) is supported on a substrate holder (5) in such a way that a substrate surface (15) that is to be coated is exposed and is directed downwardly, and the substrate (13) is rotated along with the substrate holder (5), characterized in that a cover (20) is secured on the substrate holder (5) and together with the substrate holder (5) forms a sealed chamber (36) for the substrate (5).

23. Method according to claim 29, characterized in that the substrate (13) is held on the substrate holder (5) with vacuum.

24. Method according to one of the claims 22 or 23, characterized in that the cover (20) is held on the substrate holder (5) with vacuum.

25. Method according to one of the claims 22 to 24, characterized in that the cover (20) and the substrate holder are centered relative to one another prior to the securement.

26. Method according to one of the claims 22 to 25, characterized in that the securement of the cover (20) is released after the rotational processing independently of the securement of the substrate (13).

27. Method according to one of the claims 22 to 26, characterized in that the side of the cover (20) that faces away from the substrate (13) is rinsed and/or dried during the rotational process.

28. Method according to one of the claims 22 to 27, characterized in that a rinsing or drying fluid is conveyed against the cover by means of at least one nozzle (40).

29. Method according to one of the claims 22 to 27, characterized in that the cover (20) is turned between successive rotational processes.

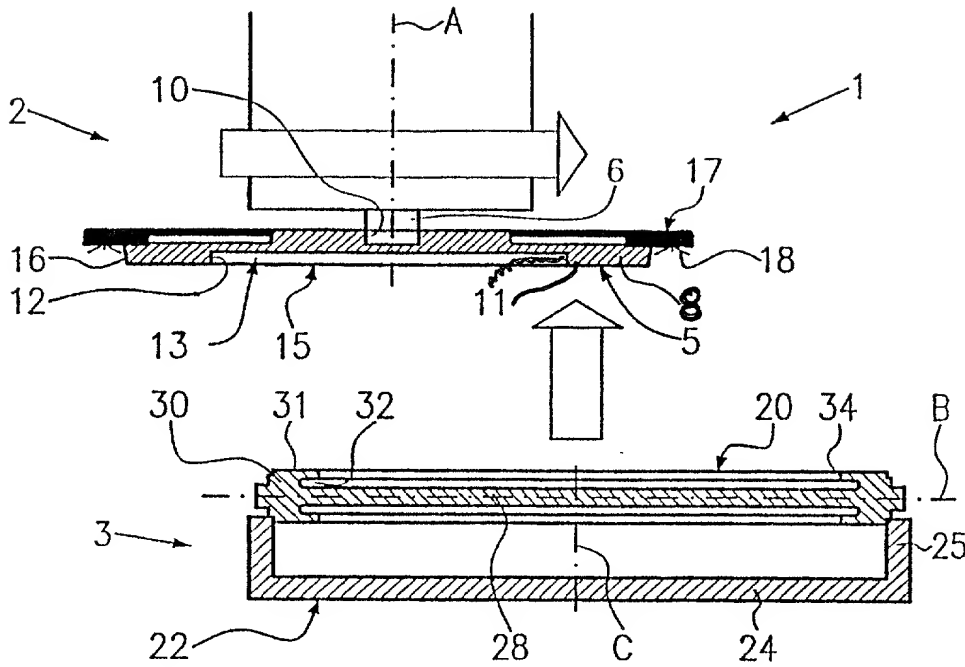


FIG. 1

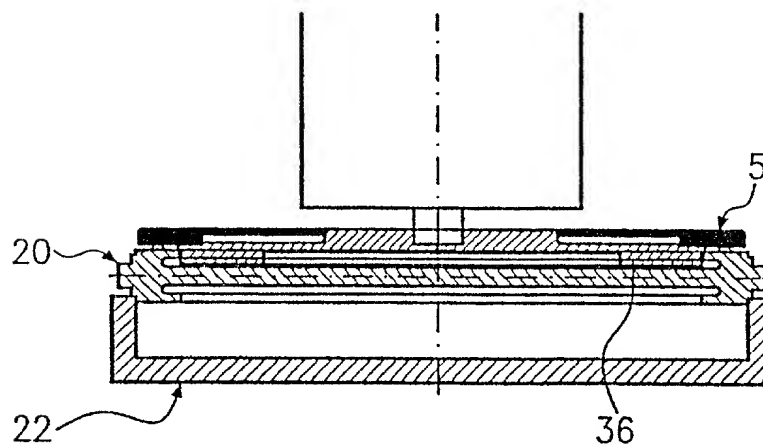


FIG. 2

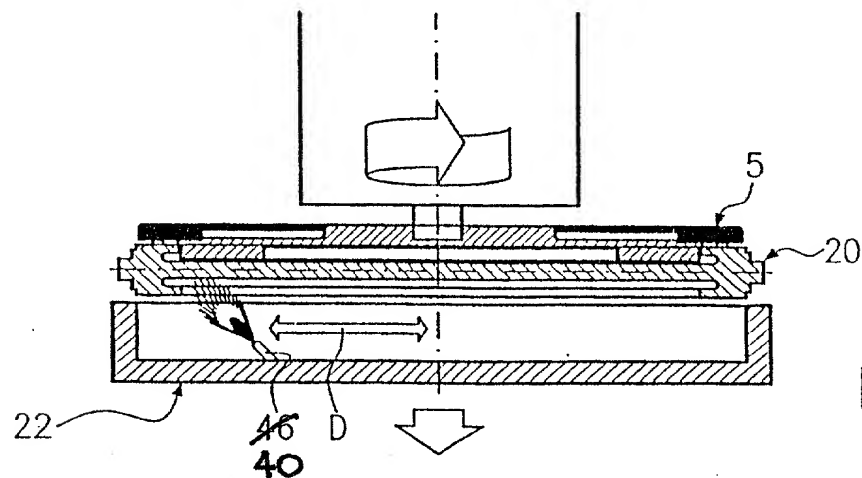
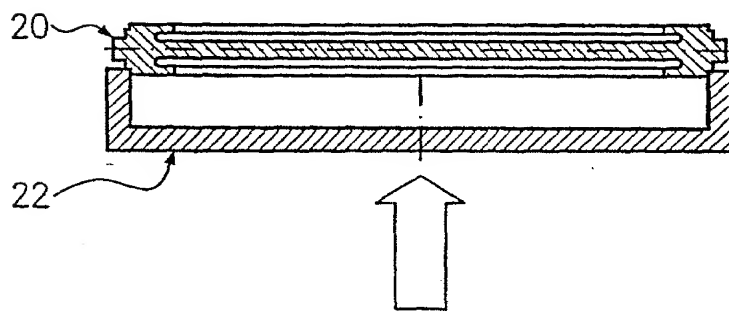
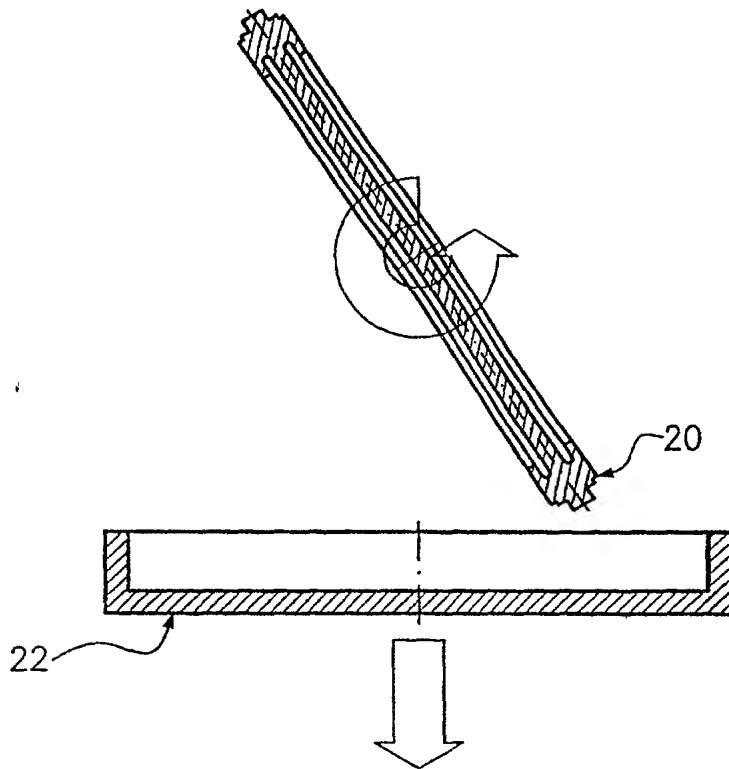
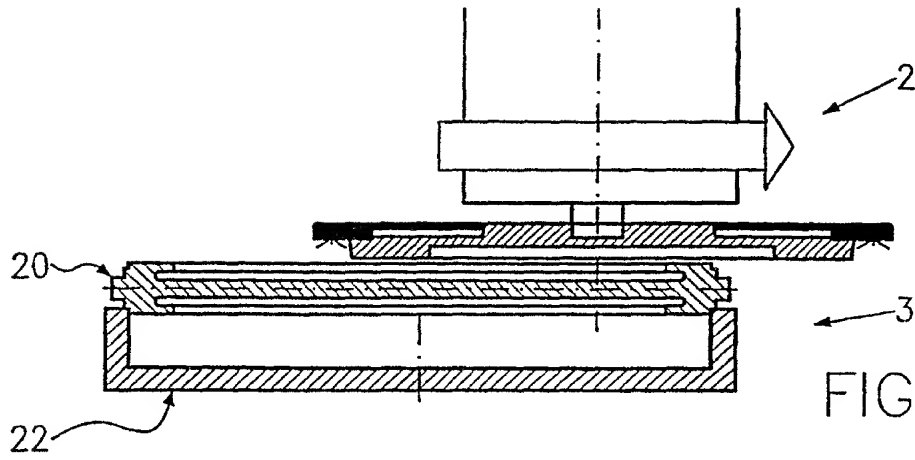


FIG. 3



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FIG.7

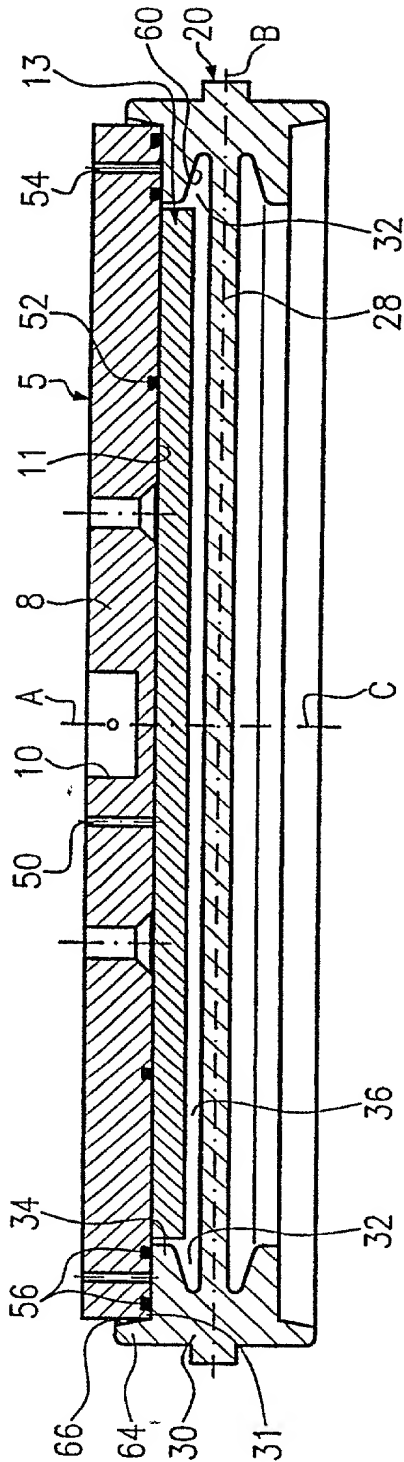
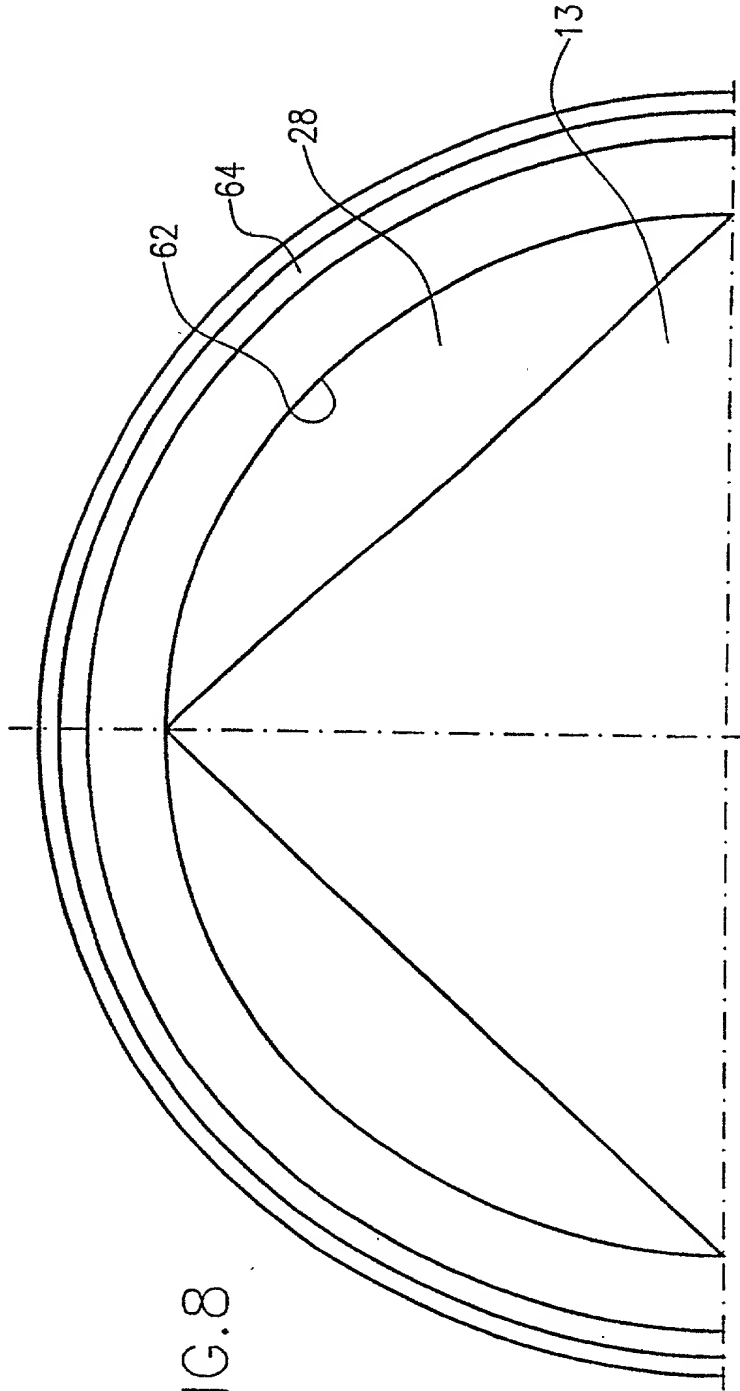


FIG.8



COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name; I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought of the invention entitled:

METHOD AND APPARATUS FOR TREATING SUBSTRATES

the specification of which

_____ is attached hereto;

_____ was filed on 19 January 2000 as International Application No. PCT/EP00/00380 and is amended herewith.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known by me to be material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s):

Priority Claimed:

Yes No

199 06 398.2 GERMANY 16 FEBRUARY 1999
(Number) (Country) (Day/Month/Year Filed)

X —

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below:

(Application Number) (Filing Date)

I hereby appoint attorney Robert W. Becker, Reg. No. 26,255, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith. Address all telephone calls to (505) 286-3511. Address all correspondence to ROBERT W. BECKER & ASSOCIATES, 11896 N. Highway 14, Suite B, Tijeras, New Mexico 87059.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Date: 26.06.2001

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